



# **G-12 Task Group No. 2010-01 Class Y: A New QML Class for Non-Hermetic Space Products**

**Task Group Meeting No. 4**  
**Baltimore, May 23, 2011**

**Shri Agarwal, Ramin Roosta, Tom Wilson**  
Jet Propulsion Laboratory, California Institute of Technology  
**David Sunderland, Larry Harzstark**

## Agenda

- Background
- Baltimore Meeting
- Section 1 - MIL-PRF-38535, Rev J, Appendix B marked up for Class Y
- Section 2 - MIL-STD-883, Rev H, and MIL-PRF-38535, Rev J (except Appendix B) updates for Class Y
- Moving Forward
- Other

## Background

Mike Sampson conceived the idea of a new Class Y for non-hermetic space parts to provide QML coverage for Xilinx Virtex-4 and similar devices.

At the San Antonio meeting, the G-12 Task Group TG 2010-01 was formed to address non-hermetic devices for space. (L. Harzstark, A. Touw)

The introductory meeting was held in Nashville.

Notes from the second meeting in Columbus:

- The space community is evaluating use of non-hermetic parts because there are no large I/O hermetic packages available and it will require a substantial investment.
- A simplified approach was discussed and adopted for this Task. (Sunderland and his team at Boeing)
- Some responders proposed extending the Class Y definition to cover organic substrates. However, the majority suggested Class Y be defined as items that are of ceramic, non-hermetic construction that must pass all applicable Appendix B requirements.

Notes from the third meeting in Tempe:

- The space community approved the concept phase. The “written” phase is next. Suggested holding telecon.

## Baltimore Meeting

### **Class Y requirements using the simplified approach:**

- Ceramic based non-hermetic parts are addressed.
- This would put a QML standard in place and enable the space agencies, primes and suppliers to initiate the procurement of flight parts.
- The organic non-hermetics could be worked on as Phase 2 of this TG or a new TG could be opened.
- We'll continue monitoring hermetic parts availability.

### **This review contains two sections:**

1. MIL-PRF-38535, Rev J, Appendix B marked up for Class Y.
2. MIL-STD-883, Rev H, and MIL-PRF-38535, Rev J (except Appendix B) updates for Class Y.

### **Question: what is a space flight part?**

- Land Grid Array, LGA, configuration (yes, because it goes thru screening and qual.)
- Column Grid Array, CGA, configuration (debatable because testing is limited to visual inspection, room temp electricals, sample column pull test – and not everyone does them. The manufacturers and/or subs should issue application notes to guide users.)

# Baltimore Meeting

Cont'd

## **Moving Forward:**

We should let DLA Land and Maritime take over from here and support both DLA-VA and DLA-VQ to:

- Add requirements for Class Y in MIL-PRF-38535 (VA), and perform audits of suppliers to those requirements (VQ).
- This whole process could take another 6 to 12 months.
- Ensure the process conforms to existing G12 rules.

# NEPAG – OneSpace Community



NEPAG

## Section 1

MIL-PRF-38535, Rev J  
Appendix B marked up for Class Y

## Proposed Additions to Appendix B

B.5 Non-Hermetic Space Level Microcircuits – Class Y. This section presents the requirements that are to be used to supplement this specification for non-hermetic ceramic based space level microcircuits, hereinafter referred to as Class Y.

Requirements for Class Y products with solder terminations e.g. ball grid array (BGA) or column grid array (CGA) packages, are covered under Para B.6 herein. Class Y microcircuits must obey all previous provisions of Appendix B, except as follows:

B.5.1 Part Identifying Number (PIN). Each Y level QML microcircuit shall be marked with the device Class designator “Y” in place of the “V” designator in the PIN format, see 3.6.2a in the main body of this document.

B.5.2 Class Y Assembly Material: For flip chip assembly, solder bump material content shall be specified on device SMD.

B.5.3 Shelf Life Caution. Sealed dry packs and/or storage in dry nitrogen environment shall be required for class Y devices where the non-hermetic nature of Class Y devices would expose the under-fill and/or thermal grease/epoxy to atmosphere moisture. A moisture sensitivity level (MSL) sticker shall be attached on the dry packs.

B.5.4 Use of Passive Parts to Enhance Performance of Die. Chip capacitors used for Class Y devices must follow requirement specified in paragraph 3.15 and 3.15.1 for space products.

## Proposed Additions to Appendix B

### B.5 Non-Hermetic Space Level Microcircuits – Class Y (Cont'd)

B.5.5 Screening. For Class Y, the following exceptions apply to the screening tests specified in the main body of this specification and this Appendix.

- a. Nondestructive bond pull (NDBP) does not apply to flip-chip devices.
- b. Particle impact noise detection (PIND) does not apply to devices without a cavity.
- c. Seal test (TM1014) is not required.
- d. Confocal scanning acoustic microscopy (CSAM) may be substituted for radiographic inspection on approval by QA.
  - d.1. CSAM tests on the flip chip underfill of each device shall be done per TM2030.
  - d.2. When heat sink and/or lid is attached to the class Y device, CSAM as above shall also be used when epoxy or thermal grease are used to attach the heat sink and/or lid directly to the back side of the flip chip die.

# Proposed Additions to Appendix B

## B.5 Non-Hermetic Space Level Microcircuits – Class Y (Cont'd)

B.5.6 Technology Conformance Inspection (TCI). For Class Y, the following exceptions apply to the TCI tests specified in the main body of this specification and earlier in this Appendix.

a.Group A. No exceptions.

b.Group B. Exceptions and additional requirements are as follows: (i) Subgroup 1. Resistance to solvents is not required for laser marked devices (no ink mark on devices). (ii) Subgroup 2. Bond pull test is not required for flip chip assembly. Die shear test or stud pull shall be replaced with assembly in-line flip-chip pull-off test per TM2031, this test shall be done prior to under fill dispense. (iii) Class Y package with lid/heat sink attached on the back side of the flip chip die shall require the lid shear or lid torque test. Manufacturers shall submit test procedures for approval by QA for lid shear test. Lid Torque test may follow TM2024 methodology.

c.Group C. No exceptions.

d.Group D. *Exceptions and additional requirements are as follows: (i) Seal test (TM1014) and internal water vapor (TM1018) are not required. (ii) Lid torque (TM2024) is optional (?) for devices with lid or heat sink attached to the backside of the flip chip die. (iii) Manufacturers are responsible for ensuring the package meets all appropriate Group D tests as defined in MIL-STD-883, TM5005.* For Class Y, a Packaging Integration Demonstration Test Plan (PIDTP) shall be submitted to QA for approval. This plan must address issues unique to non-hermetic construction and materials, such as potential materials degradation (e.g. out-gassing – see MIL-STD-883 TM5011 and moisture absorption), resistance of active devices, passive devices, interconnect and passivation to environment (e.g. moisture, hydrogen or other contaminants), resistance to processing stresses and shelf life. The PIDTP plan shall be approved by QA after consultation with the space community. Following demonstrations shall be included as a minimum: (a) Moisture sensitivity level characterization for exposed flip chip under-fill and/or thermal grease/epoxy (ref: JEDEC J-STD-020D). (b) Flip chip under-fill qualification (Ref: MIL-STD-883, TM5011).

## Proposed Additions to Appendix B Cont'd

**B.6 Solder-Terminated Microcircuits.** This section presents the requirements that are to be used to supplement this specification and the other applicable appendices for space level microcircuits with solder terminations (e.g. Ball Grid Array – BGA or Column Grid Array – CGA). Solder terminated microcircuits just obey all provisions of Appendix B (including those of Para B.5 as applicable), except as follows:

**B.6.1 Assembly Material:** The material contents for solder balls and solder columns shall also be specified on device SMDs.

**B.6.2 Shelf Life Caution:** The solder ball/columns oxidize when exposed to atmosphere. It is estimated that sealed dry pack may prevent solder from oxidizing for about 2 years. Storage in dry nitrogen is recommended.

**B.6.3 Screening.** For solder-terminated microcircuits, the following exceptions apply to the screening tests specified in the main body of this specification and this Appendix:

a. All required screening steps (including electrical test and burn-in) shall be performed prior to attachment of solder balls or columns on approval of QA. Following ball/column attachment, (a) perform electrical tests over operating temperature range. Any exceptions shall be approved by QA. (b) visual inspection shall be performed according to TM 2009 of MIL-STD-883 (section 3.3.6).

## Proposed Additions to Appendix B Cont'd

B.6.4 Technology Conformance Inspection (TCI). All required TCI tests shall be performed prior to the attachment of solder balls and solder columns to the package substrates. The following exceptions apply to the TCI tests specified in the main body of this specification and earlier in this Appendix.

- a. Group B. Exceptions and additional requirements are as follows: Solderability test is not required for BGA and CGA packages. Solderability test has been verified during solder ball and solder column attachment processes. Each BGA ball attachment lot shall have ball shear test (ref: JESD22-B117) or ball pull test (Ref: JESD22-B115) done. (vi) Each CGA column attachment lot shall have column pull or shear test done.
- b. Group D. Lead integrity (TM2004) and Adhesion of lead finish (TM2025) are not required for BGA and CGA packages. A Packaging Integrity Demonstration Test Plan (PIDTP) shall be submitted to QA for approval. This plan must address issues unique to solder terminations, such as ball/column integrity, attachment integrity, damage due to test, protection for shipment and shelf life. The PIDTP plan shall be approved by QA after consultation with the space community. For BGA and CGA packages, board level reliability shall be demonstrated. IPC-9071 may be used as a guideline for the test requirement. Note that IPC-9071 preferred test condition, 0C to 100C, may not be sufficient to meet space level.

## Section 2

MIL-STD-883, Rev H, and MIL-PRF-38535, Rev J  
(except Appendix B updates for Class Y)

# Other Proposed Changes

## 883

MIL-STD-883H  
26 February 2010  
METHOD 2009.10  
EXTERNAL VISUAL

1. PURPOSE. The purpose of this test method is to verify the workmanship of hermetic and ceramic based non-hermetic devices. This test method shall also be utilized to inspect for damage due to handling, assembly, and/or test of the packaged device. This examination is normally employed at outgoing inspection within the device manufacturers facility, or as an incoming inspection of the assembled device. (Page 1)

3.1.21 Class level B and class level S. 2 class levels are used in this document to define requirements for high reliability military applications (Class level B) and space applications (Class level S). Class level B requirements contained in this document are intended for use for Class Q, Class H, and Class M products, as well as Class B M38510 JAN slash sheet product. Class level B requirements are also intended for use for product claimed as 883 compliant or 1.2.1 compliant for high reliability military applications. Class level S requirements contained in this document are intended for use for Class Y, Class V, Class K, as well as M38510 Class S JAN slash sheet product. Class level S requirements are also intended for use for product claimed as 883 compliant or 1.2.1 compliant for space level applications. (Main Body, Page 8)

## Other Proposed Changes 38535 J

3.4.2.1 Qualification extension. When a basic plant desires to qualify a device or process flow that includes an offshore site, application for certification and qualification may be extended with QA approval under the following conditions:

- a. Control and approval of the design, fab, assembly and test operations by the manufacturer's TRB is required along with periodic self-assessments of the offshore sites. The manufacturer's TRB shall review all screening and TCI tests to determine whether they should be performed exclusively in the offshore site or reserved for the basic plant in order to assure quality and reliability. The manufacturer's TRB assessment shall be made available to the QA for review or approval as appropriate.
- b. QA certification of the offshore site is required. For class Q, Y and V products all operations, sites, and plants shall be QA certified however, this certification may be issued through the manufacturer's TRB with QA approval. Validation of these offshore operations is also required. For assembly site(s) an initial site shall be certified and qualified by the QA. Additional assembly sites shall be assessed subsequent to the initial validation. (Main Body Page 9)

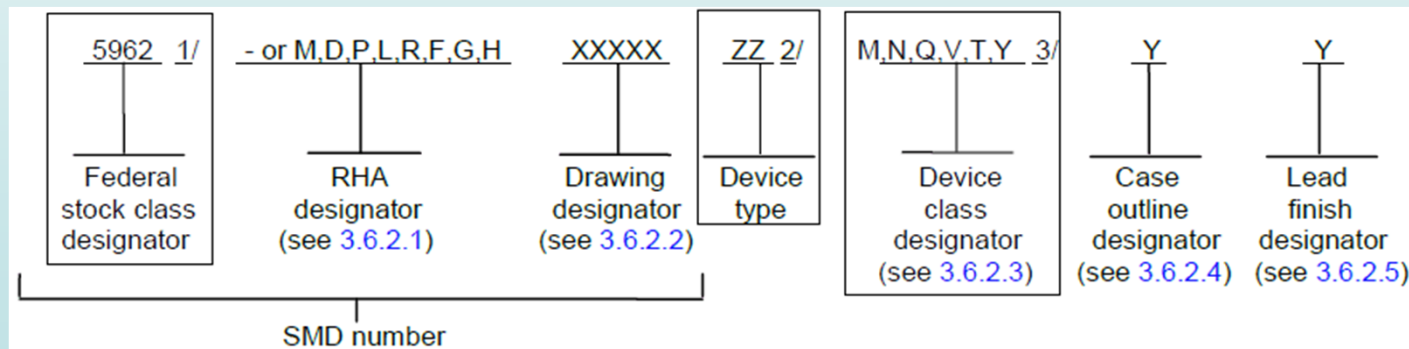
# Other Proposed Changes

## 38535 J Cont'd

SMD Number

3.6.2 Part Identification Number (PIN). Each QML microcircuit shall be marked with the complete PIN. The PIN may be marked on more than one line provided the PIN is continuous except where it "breaks" from one line to another. As of revision B of MIL-PRF-38535, several types of documents are acceptable for use when specifying QML microcircuits. They are MIL-M-38510 device specifications and SMD. The PIN marked on those parts under QML shall be the same as when supplied by the manufacturer prior to being listed on the QML-38535. The "Q" or "QML" designator combined with the listing of that PIN on a particular vendors QML listing shall indicate the fact that the manufacturer of the device is QML certified and qualified for the processes used to build that product. The PIN system shall be of one of the following forms, as applicable to the SMD or MIL-M-38510 device specification used for production: (Main Body, Page 12)

a. SMD PINs shall be as follows



## Other Proposed Changes

### 38535 J Cont'd

3.6.8 QML marked product. For QML certified and qualified manufacturers and manufacturers who have been granted transitional certification (see H.3.3), standard product (Joint Army Navy (JAN), class M SMDs, and military temperature range class B data book product), produced on a QML flow may be marked with the "Q" or "QML" certification mark. This allowance applies to contractor prepared drawings covering standard product only if the drawing was released prior to 31 December 1993 or the date the manufacturer becomes QML whichever is the later date, and the part is marked with the standard part number. A list of the manufacturer's military temperature range product to be included under QML shall be submitted to the QA for approval. Contractor prepared drawings written for nonstandard parts may not be marked with a "Q" or "QML". The only exception to this requirement is an altered item drawing required by a device specification or SMD.

Only parts covered by a MIL-M-38510 device specification, an SMD, or generic parts that have been grandfathered (a list of eligible devices shall be submitted to DSCC-VA or DSCC-VQ for review) shall be listed on QML-38535. After 31 December 93, new QML products, which are marked with a "Q" or "QML" certification mark, shall be documented on an SMD (see 3.5). Any device that is not processed in compliance with the provisions of MIL-PRF-38535 shall not be claimed to be compliant. Non-compliant products shall not contain "QML", "QMLY", "QMLV" or any variant thereof within the vendor part number or within any marking located on the package. (Main Body, Page 15)

## Other Proposed Changes

### 38535 J Cont'd

4.3 Technology conformance inspection (TCI). All product shipped shall be capable of passing TCI in accordance with tables II, III, IV, and V; for plastic packages see Table IB herein. With QA approval when TM 5005 of MIL-STD883 is used as a TCI option, class Q shall be capable of passing the class level B flow and class V shall be capable of passing the class level S flow. Class Y shall be capable of passing the flow as defined in Appendix B. When selecting the TM 5005 TCI option for class V, the group B end-point electricals shall be the same as the group C end-point electricals, unless otherwise specified in the acquisition document. TCI testing shall be accomplished by the manufacturer on a periodic basis to assure that the manufacturer's quality, reliability, and performance capabilities meet the requirements of the QM plan (see G.3.3). Where appropriate, as an option, in place of the fixed sample size (Acceptance number) the manufacturer may use the sample size series (SSS) plan of Appendix D. (Main Body, Page 17).

# Other Proposed Changes

## 38535 J Cont'd

6.4.28 Class N. Items which have been subjected to and passed all applicable requirements of this specification including qualification testing, screening testing, and TCI/QCI inspections, and are encapsulated in plastic. This product must be assessed by the user to determine if it is appropriate for use in users' application.

6.4.29 Class Q. Items which are hermetic and have been subjected to and passed all applicable requirements of this specification and applicable appendices including qualification testing, screening testing, and TCI/QCI inspections.

6.4.30 Class V. Items that are hermetic and meet all the class Q requirements, and have been subjected to, and passed all applicable requirements of appendix B herein.

6.4.31 Class Y. Items that are ceramic based non-hermetic , and have been subjected to, and passed all applicable requirements of Appendix B herein.

**6.4.32** Class B.

**6.4.33** Class S.

**6.4.34** Class T.

**6.4.35** Qualified manufacturer's line.

**6.4.36** Test optimization.

**6.4.37** Audit team.

**6.4.38** Class level B.

**6.4.39** Class level S.

**6.4.46** Storage Temperature.

**Paragraph  
numbers  
only were  
changed.**

# Other Proposed Changes

## 38535 J Cont'd

A.3.5 Design and construction. Microcircuit design and construction shall be in accordance with all the requirements specified herein and in the device specification or drawing.

A.3.5.1 Package. All devices supplied under this appendix except for Class Y shall be hermetically sealed in glass, metal, or ceramic (or combinations of these) packages. No organic or polymeric materials (lacquers, varnishes, coatings, adhesives, greases, etc.) shall be used inside the microcircuit package unless specifically detailed in the device specification or drawing (e.g., polyimide interlayer dielectric). Alpha Particle protection is permitted if permitted by the device specification or drawing. Desiccants may be used in the microcircuit package (except for class level S devices where they are prohibited) only if each lot is subjected to and passes an internal water vapor test, test method 1018 of MIL-STD-883, with a limit of 1,000 ppm at +100°C for a sample of 3(0) or 5(1). The internal moisture content for class level S devices, after completion of all screening, shall not exceed 5,000 ppm at +100°C. Polymer impregnations (backfill, docking, coating, or other uses of organic or polymeric materials to effect, improve, or repair the seal) of the microcircuit packages shall not be permitted. Polymer coating used to effect or improve marking adhesion shall not be applied over lid seal area. (Main Body, Page 48)

## Other Proposed Changes

### 38535 J Cont'd

A.3.5.6.2 Lead or terminal material. Lead or terminal material shall conform to one of the following compositions:

- a. Type A: Iron-nickel-cobalt alloy: SAE-AMS-I-23011, class I, ASTM F15.
- b. Type B: Iron-nickel alloy (41 percent nickel): SAE-AMS-I-23011, class 5, ASTM F30.
- c. Type C: Co-fired metallization such as nominally pure tungsten. The composition and application processing of these materials shall be subject to QA approval and submitted with application to test and as otherwise requested by the QA.
- d. Type D: Copper-core, iron-nickel ASTM F30 alloy (50.5 percent nickel). The core material shall consist of copper (oxygen-free), ASTM B170, grade 2.
- e. Type E: Copper-core ASTM F15 alloy. The core material shall consist of copper (oxygen-free) ASTM B170, grade 2.
- f. Type F: Copper (oxygen-free) ASTM B170, grade 2. This material shall not be used as an element of any glass-to-metal seal structure.
- g. Type G: Iron-nickel alloy (50.5 percent nickel): SAE-AMS-I-23011, class 2, ASTM F30.
- h. Type H: Tin-lead alloy solder balls or columns.

## Other Proposed Changes

### 38535 J Cont'd

A.3.5.6.3 Microcircuit finishes. Finishes of all external leads or terminals and all external metal package elements shall conform to either A.3.5.6.3.2 or A.3.5.6.3.3, as applicable. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. The tin content of solder shall not exceed 97 percent. Tin shall be alloyed with a minimum of 3 percent lead by weight. The lead finish designator (see A.3.6.2.7) shall apply to the finish of the leads or terminals. The leads or terminals shall meet the applicable solderability and corrosion resistance requirements. The other external metallic package elements (including metallized ceramic elements) shall meet the applicable corrosion resistance requirements. Finishes on interior elements (e.g. bonding pads, posts, tabs) shall be such that they meet the lead bonding requirements and applicable design and construction requirements. The use of strike plates is permissible to the maximum thickness of 10 microinches (0.25 micrometer). All plating of finishes and undercoats shall be deposited on clean, non-oxidized metal surfaces. Suitable de-oxidation or cleaning operations shall be performed before or between plating processes. All parts shall be capable of meeting the following requirements of MIL-STD-883, as applicable. (Appendix A, Page 54.)